Evaluation of Mixed-Phase Microphysics Within Winter Storms Using Field Data and In Situ Observations

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Snow prediction within models is sensitive to the snow densities, habits, and degree of riming within the BMPs. Improving these BMPs is a crucial step toward improving both weather forecasting and climate predictions. Several microphysical schemes in the Weather Research and Forecasting (WRF) model down to 1.33-km grid spacing are evaluated using aircraft, radar, and ground in situ data from the Global Precipitation Mission Cold--season Precipitation Experiment (GCPEx) experiment over southern Ontario, as well as a few years (12 winter storms) of surface measurements of riming, crystal habit, snow density, and radar measurements at Stony Brook, NY (SBNY on north shore of Long Island) during the 2009--2012 winter seasons. Surface microphysical measurements at SBNY were taken every 15 to 30 minutes using a stereo microscope and camera, and snow depth and snow density were also recorded. During these storms, a vertically-pointing Ku band radar was used to observe the vertical evolution of reflectivity and Doppler vertical velocities.

The GCPex presentation will focus on verification using aircraft spirals through warm frontal snow band event on 18 February 2012. All the BMPs realistically simulated the structure of the band and the vertical distribution of snow/ice aloft, except the SBU-YLIN overpredicted slightly and Thompson (THOM) underpredicted somewhat. The Morrison (MORR) scheme produced the best slope size distribution for snow, while the Stony Brook (SBU) underpredicted and the THOM slightly overpredicted. Those schemes that have the slope intercept a function of temperature (SBU and WSM6) tended to perform better for that parameter than others, especially the fixed intercept in Goddard. Overall, the spread among BMPs was smaller than in other studies, likely because there was limited riming with the band. For the 15 cases at SBNY, which include moderate and heavy riming events, the non--spherical snow assumption (THOM and SBU--YLIN) simulated a more realistic distribution of reflectivity than spherical snow assumptions in the WSM6 and MORR schemes. The MORR, WSM6, and SBU schemes are comparable to the observed velocity distribution in light and moderate riming periods. The THOM is ~0.25 m s^{-1} too slow with its velocity distribution in these periods. In heavier riming, the vertical Doppler velocities in the WSM6, THOM, and MORR schemes were ~0.25 m s^{-1} too slow, while the SBU was 0.25 to 0.5 m s^{-1} too fast because of some excessive cloud water issues.